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E. A. WATSON ET AL
LIQUID FUEL PUMP GOVERNOR
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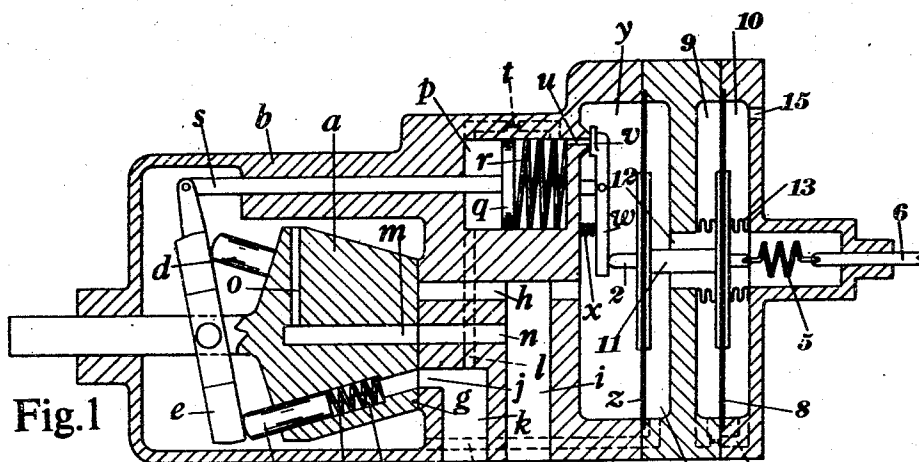


Fig. 1

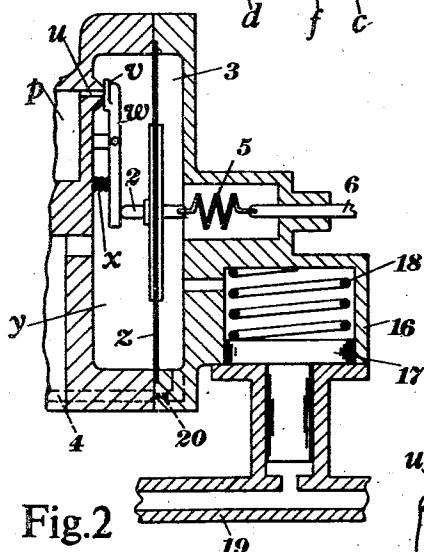


Fig. 2

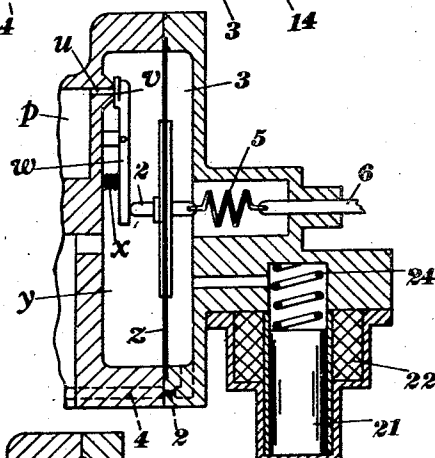


Fig. 3

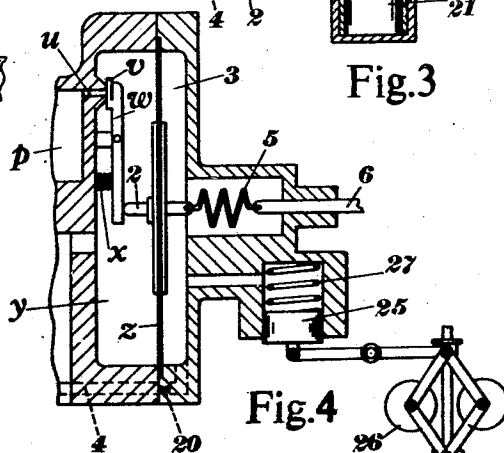


Fig. 4

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LIQUID FUEL PUMP GOVERNOR

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This invention relates to governors for automatically controlling in response to variations of speed the supply of liquid fuel from a pump to a prime mover, the object of the invention being to provide an improved governing means of the kind which is dependent upon the action of fluid pressure, this pressure being dependent on the speed of the prime mover.

The invention comprises the combination with a main governing means of the kind specified, of a supplementary governing means responsive (directly or indirectly) to a rate of change of speed.

In the accompanying sheet of explanatory drawings:

Figure 1 is a diagrammatic sectional elevation of a liquid fuel pump embodying the invention.

Figures 2 to 4 are similar diagrammatic fragmentary sectional side views illustrating respectively three modified forms of the invention.

The liquid fuel pump shown in the drawings, comprises a rotary body part *a* arranged in a casing *b* and having formed around its axis a plurality of bores as *c* in each of which is arranged a reciprocating plunger *d*. The body part *a* is adapted to be driven in any convenient manner by the prime mover (not shown) to be supplied with liquid fuel from the pump. During rotation of the body part *a* the plungers *d* are moved in one direction by an angularly movable swash plate *e* and in the opposite direction by springs as *f*, the latter being situated within the bores *c*, and serving to hold an end face of the body part in contact with a flat seating *g* in the casing *b*. The seating *g* is formed with a port *h* communicating with a liquid inlet *i* in the casing *b*, and with another port *j* communicating with a liquid outlet *k* in the casing.

To enable the pump above described to be governed in response to variations in speed, the body part *a* is adapted to serve also as a centrifugal pump. Thus, the body part *a* is formed with an axial bore *m* which at one end communicates with the inlet *i* through another port *n* in the seating *g*, and at the other end communicates with a plurality of radial passages as *o* in the body part. Liquid from the inlet *i* flows through the bore *m* and is expelled by centrifugal action through the radial passages *o* into the interior of the pump casing *b* around the body part *a*. In one end of the pump casing *b* is formed a cylinder *p* having closed ends. Within the cylinder *p* is arranged a piston *q* loaded by a spring *r*, and extending from one side of this piston and through a bore in the casing *b* at the

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inner end of the cylinder is a rod *s* connected to the swash plate *e*. The inner portion of the cylinder *p*, that is the portion at the piston-rod side of the piston *q*, is in free communication with the outlet *k* through a passage *l* in the casing *b*, and this portion of the cylinder also communicates with the other or outer portion of the cylinder (which contains the spring *r*) through a restricted passage *t*. The outer end of the cylinder *p* is provided with a small vent *u* which at its outer end forms a seating for a closure member *v* on one end of a lever *w*, the latter being pivoted at a position intermediate its ends on the outer end of the cylinder, and being loaded by a spring *x* which tends to hold the closure member on its seating. The lever *w* is contained in a chamber *y* formed on or secured to the adjacent end of the casing *b*, and this chamber communicates with the pump inlet *i*. The outer side of the chamber *y* is bounded by a controlling diaphragm *z* having at its centre an abutment 2 which is adapted to bear on the end of the lever *w* remote from the closure member *v*. At the outer side of and bounded in part by the diaphragm *z* is another chamber 3, this latter chamber being in communication with the above-mentioned centrifugal pump through a passage 4 in the casing *b*. Also the diaphragm *z* is loaded by a spring 5 connected to an adjusting member 6, the latter being operable in any convenient manner by an attendant to vary the effect of the spring.

Assuming the swash plate *e* to be in the position of maximum obliquity, that is to say the position in which the pump gives its maximum output, the swash plate will remain in this position so long as the pressure in the chamber 3 (and thus acting on the controlling diaphragm *z*) is below some predetermined amount. In this condition the vent closure member *v* is in its closed position and the liquid pressures at the two sides of the piston *q* are equal. But when the pressure acting on the diaphragm *z* exceeds the predetermined amount the diaphragm will move the closure member *v* off its seating. The liquid pressure in the outer portion of the cylinder *p* will now fall and the piston *q* will be moved by the fluid pressure in the inner portion of the cylinder against the action of the spring *r*, so moving the swash plate *e* in the direction for reducing the pump output until a new condition of equilibrium is reached.

From the foregoing it will be seen that as the position of the swash plate *e* is dependent on the pressure of the liquid in the chamber 3 and as

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this pressure is dependent on the speed of the pump, the latter is governed by the speed of the prime mover which drives the pump.

In carrying the invention into effect we combine with the chamber 3 supplementary governing means whereby additional pressure can be applied to the diaphragm 2 in response to the rate of speed changes of the prime mover. Typical examples of such means are illustrated in the drawings.

In the example shown in Figure 1 there is provided on the outer side of the chamber 3 another chamber which is divided by a second diaphragm 8 into two compartments 9, 10, this diaphragm being arranged parallel with the first diaphragm 2, and being connected thereto by an axial rod 11 passing through an opening 12 in the adjacent side of the chamber 3. The outer compartment 10 is provided at its outer side with a central enlargement which accommodates the spring 5, the latter being connected at one end to the second diaphragm 8 and at the other end to the adjusting member 6. The central portions of the compartments 9, 10 which accommodate the rod 11 and the spring 5 are separated from the main portions of these compartments by any convenient seal such as flexible metal bellows 13. Also the main portions of the two compartments 9, 10 are interconnected by a restricted passage 14, and the main portion of the outer compartment 10 is provided with an inlet 15 whereby it can be connected to an air blower (not shown) driven by the prime mover, or to any other source of fluid pressure which varies with changes of speed of the prime mover.

Normally the fluid pressures in the compartments 9, 10 are equal, but rapid increase in the speed of the prime mover causes pressure to be built up in the outer compartment 10 and this pressure is transmitted through the second diaphragm 8 to the first diaphragm 2 for actuating the lever *w* of the closure member *v*.

In the example shown in Figure 2 the additional pressure is applied to the diaphragm 2 through the liquid in the chamber 3. Thus we provide in communication with the chamber 3 the larger end of a stepped cylinder 16 containing a correspondingly stepped piston 17 loaded by a spring 18, the smaller end of the cylinder being connected by a pipe 19 to the pump outlet above described. Also the passage 4 connecting the chamber 3 with the centrifugal pump is provided with a restriction 20 which enables additional pressure to be established in the chamber by the action of the stepped piston 17. With increasing pressure in the pump outlet the piston 17 moves against the action of its spring 18 and displaces liquid from the cylinder 16 to the chamber 3, thereby producing in the chamber an additional pressure which is dependent on the rate of change of pressure in the pump outlet and the size of the restriction 20 in the passage 4.

In the example shown in Figure 3, the required additional pressure in the chamber 3 is obtained by means of a piston 21 which forms the movable core of an electromagnet, having an energising winding 22, the latter being supplied with current from a generator whose output is correlated with the speed of the prime mover and serving to move the piston against the action of a spring 24.

In the example shown in Figure 4, the additional pressure in the chamber 3 is obtained by means of a piston 25 subject to the action of a centrifugal mechanism 26 which is responsive to the speed of the prime mover, and which serves

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to move the piston against the action of a spring 27.

From the above described examples it will be seen that the required supplementary governing action may be derived from a variety of different means (fluid, electromagnetic, or mechanical) adapted to exert pressure which is directly or indirectly dependent on change of speed of the prime mover.

By the use with a main fluid-operated governing means of a supplementary governing means responsive to and operative during a change of speed as above described, we are able to obtain a more satisfactory control of the fluid supply consequent on changes in the speed of the prime mover than is obtainable with the main governing means alone.

The invention is not, however, restricted to the examples given, as subordinate details may be varied to suit different requirements. Moreover the invention is applicable to liquid fuel pumps other than that above described.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. Means for supplying liquid fuel to a prime mover, comprising a variable-delivery pump having in combination a rotary body part provided with a plurality of bores, fluid inlet and outlet passages with which the bores communicate during rotary motion of the body part, an adjustable member for varying the stroke of the plungers and thereby varying the output of the pump, a main governing means adapted to vary the position of the said adjustable member in response to fluid pressure dependent on the speed of the said rotary body part, and a supplementary governing means adapted to co-operate with the main governing means for imparting movement to the adjustable member in response to the rate of change of the said speed.

2. Means for supplying liquid fuel to a prime mover, comprising a variable-delivery pump having in combination a rotary body part provided with a plurality of bores, fluid inlet and outlet passages with which the bores communicate during rotary motion of the body part, an adjustable member for varying the stroke of the plungers and thereby varying the output of the pump, a main governing means provided with a transmission member adapted to vary the position of the adjustable member under the pressure of fluid delivered by the pump, and with a device responsive to fluid pressure dependent on the speed of the said rotary body part for controlling the movement of the transmission member, and a supplementary governing means adapted to exert a further control on the movement of the transmission member by acting on the said device in response to the rate of change of the said speed.

3. Means for supplying liquid fuel to a prime mover, comprising a variable-delivery pump having in combination a rotary body part provided with a plurality of bores, fluid inlet and outlet passages with which the bores communicate during rotary motion of the body part, an adjustable member for varying the stroke of the plungers and thereby varying the output of the pump, a main governing means provided with a transmission member adapted to vary the position of the adjustable member under the pressure of fluid delivered by the pump, and with a device responsive to fluid pressure dependent on the speed of the said rotary body part for controlling

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the movement of the transmission member, a supplementary governing means including a pressure-transmitting member movable by fluid pressure and adapted to exert a further control on the movement of the transmission member in response to the rate of change of the said speed, and means connecting the said pressure-transmitting member to the said device.

4. Means for supplying liquid fuel to a prime mover, comprising a variable-delivery pump having in combination a rotary body part provided with a plurality of bores, fluid inlet and outlet passages with which the bores communicate during rotary motion of the body part, an adjustable member for varying the stroke of the plungers and thereby varying the output of the pump, a main governing means provided with a transmission member adapted to vary the position of the adjustable member under the pressure of fluid delivered by the pump, a device responsive to fluid pressure for controlling the movement of the transmission member, a chamber bounded in part by the said device, a restricted passage through which fluid can enter the chamber at a pressure dependent on the speed of the said rotary body part, and a supplementary governing means comprising a cylinder in communication with the chamber, and a piston movable in the cylinder and adapted by varying the pressure in the said chamber to exert a further control on the move-

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ment of the transmission member in response to the rate of change of the said speed.

5. Means as claimed in claim 4, in which the piston is movable by fluid pressure.

6. Means as claimed in claim 4 and having electromagnetic means for actuating the piston.

7. Means as claimed in claim 4 and having a centrifugal mechanism for actuating the piston.

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